S
1
A28

APR 23 1941

AGRICULTURAL NEWS LETTER

VOL. 9 - NO. 2 MARCH-APRIL, 1941

This publication contains information regarding new developments of interest to agriculture based on laboratory and field investigations of the du Pont Company and its subsidiary companies. It also contains published reports and direct contributions of investigators of agricultural experiment stations and other institutions as related to the Company's products and other subjects of agricultural interest.

DU PONT
REG. U. S. PAT. OFF.

ISSUED BY PUBLIC RELATIONS DEPARTMENT, E. I. DU PONT DE NEMOURS & CO. (INC.), WILMINGTON, DEL.

Vol. 9 - No. 2 Mar.-Apr., 1941

AGRICULTURAL NEWS LETTER

Editor
L. F. Livingston, Manager,
Agricultural Extension Division.

Contributing Editors

Dr. F. W. Parker, Agronomist,
Ammonia Department.

Gilbert F. Miles, Manager,
Research Laboratory,
Bayer-Semesan Company.

Dr. W. H. Tisdale, Director,
Pest Control Research Laboratory.

Dr. H. F. Dietz, Entomologist,
Pest Control Research Laboratory.

CONTENTS

	Page
Use of Liquid Fertilizers for Growing Vegetables	17
Studies of the Keeping Qualities of Cut Flowers	22
Urea Seasoning of Tidewater Red Cypress	26
Mealybug on Apples	28
Phenothiazine for the Anthelmintic Treatment of Horses	31
Hunger Signs in Crops	33
Ammonium Sulfamate and Sulfamic Acid as Herbicides	35

Agricultural News Letter (Du Pont)
Vol. 9, No. 2, March-April, 1941

USE OF LIQUID FERTILIZERS FOR GROWING VEGETABLES

EDITOR'S NOTE: Use of chemical fertilizers dissolved in water as a starter solution and for liquid side-dressing of vegetable crops has been the subject of considerable research during the past few years. Dr. V. A. Tiedjens of the New Jersey Agricultural Experiment Station, for instance, has conducted a number of experiments with liquid fertilizers and has obtained very promising results. The method seems to be well suited for the small garden and has also been used successfully in the greenhouse and by growers who use irrigation. However, Dr. Tiedjens states that commercial growers should proceed cautiously until they have tried liquid fertilizers on a small acreage. At our request, Dr. Tiedjens has prepared the following article, giving information on this subject. Reprints will be sent on request.

By V. A. Tiedjens,
Dept. of Vegetable Gardening,
Agricultural Experiment Station,
Rutgers University,
New Brunswick, New Jersey.

Use of liquid fertilizers as a starter solution and for side-dressing vegetable crops is a relatively new procedure. Recent research work at the New Jersey Agricultural Experiment Station, however, has developed considerable data on the formulation and efficiency of liquid fertilizers, as well as amounts and methods of application.

The New Jersey experiments have shown that liquid fertilizers cannot be applied in the same way to all vegetable crops. Since such crops as snap beans and sweet corn mature in a short season, most of their plant food should be applied when the crops are planted. This can be done by plowing under dry fertilizer and using liquid only as a starter solution. A starter solution can be used at planting with such long-season crops as tomatoes, lima beans, cabbage, and sweet potatoes, followed with side-dressings of liquid fertilizers at intervals of two or three weeks.

Starter Solutions

FORMULAS: Starter solutions can be made from a wide variety of fertilizer materials. Our studies, however, indicate certain properties are essential for best results.

Continued on next page

In the first place, the starter solution should have a reaction of pH 5.0 or somewhat higher. Starter solutions made with superphosphate or triple superphosphate as the source of phosphoric acid have a reaction of about pH 3.5, and have been very unsatisfactory. In fact, they definitely injure tomato plants. If superphosphates are used in the fertilizer mixture, they should be neutralized with some ammonia liquor, lime, or other alkaline material. This is usually done in the manufacture of complete fertilizers so that most commercial fertilizers will make starter solutions having a satisfactory pH value.

The second principle to keep in mind is the relation between the nutrient content of the starter solution and its influence on the concentration of the soil solution around the seed or seedling. It seems advisable to use starter solutions which carry the desired quantity of nutrients and at the same time cause the smallest increase in the concentration of the soil solution. Experiments to evaluate the importance of this factor are still in progress. The work of White and Ross, Jour. Agr. Research, 59, 81-99, indicates that ammonium phosphate, ammoniated superphosphate, urea, potassium nitrate, and potassium sulfate are sources of nutrients that cause very small increases in the concentration of the soil solution. All of these materials have given very good results in starter solutions.

The following are two examples of concentrated high-nitrogen mixtures (13-26-13 and 10.5 - 21.5 - 21.5) that (1) are quickly soluble; (2) give good results on either limed or unlimed soils; (3) have a suitable pH for a starter solution; and (4) are well suited for side-dressing purposes, as well.

	13-26-13	10.5-21.5-21.5
"Ammo-Phos" 11% N-48% P_2O_5	1092 lbs.	900 lbs.
Muriate of potash 60% K_2O	440	715
Sulfate of ammonia 20.5% N	100	80
Nitrate of soda 16% N	120	100
"Uramon" 42% N	248	205
	2000	2000

These mixtures contain approximately 1.0% CaO derived from the "Ammo-Phos" and "Uramon" fertilizer compound. They have, nevertheless, given excellent results on unlimed as well as limed soils when used in starter solutions.

The calcium content of the starter solutions may be increased by adding calcium sulfate to the mixture. It, however, is impossible to get much calcium in solution due to the high content of phosphoric acid and relatively high reaction, pH 5.0. The most satisfactory and economical way to provide calcium when using starter solutions and liquid fertilizers is to follow a good liming program.

FOR TRANSPLANTING: The starter solution is made by dissolving 2 to 10 pounds of fertilizer, depending on the analysis, in 50 gallons of water. This solution is then used instead of water for setting out the plants. If dry fertilizers are to be used in fertilizing the crop, the best procedure is to spread

Continued on next page

it broadcast before plowing and depend on the starter solution to give the plants a good start. The most striking results from starter solutions will be secured on soils of low and medium fertility.

FOR SEED PLANTING: Starter or transplanting solutions can be used when seed is sown. Good crops of sweet corn, snap beans, and lima beans have been produced by drilling with the seed, 25 to 50 pounds of special fertilizer mixtures in 50 gallons of water, applied at the rate of 200 gallons per acre. While 200 gallons of solution per acre is usually an economic application, it is desirable to use more water, if possible, because a greater dilution will give better distribution of the fertilizer. If more than 200 pounds of fertilizer are used, part of it may be applied in the drill with the seed and the remainder in one or more side-dressings. Not more than 100 pounds of the 13-26-13 or the 10.5-21.5-21.5 mixtures, previously mentioned, are needed per acre above of lima or snap beans.

Solutions for Side-Dressings

Liquid fertilizers for side-dressings are similar to starter solutions except they are very much more concentrated. This makes it possible to apply substantial amounts of plant food per acre without using large amounts of water. Thus, 50 pounds of 13-26-13 can be dissolved in 50 gallons of water. If such a solution is used at the rate of 200 pounds per acre, it is equivalent to an application of 520 pounds of 5-10-5 per acre.

FORMULAS: Fertilizer solutions for side-dressing on well-limed soils need contain very little, if any, calcium. If ammonium phosphate ("Ammo-Phos") is used in mixtures, salts that dissolve immediately can be used in the solution. Double and triple-strength fertilizer mixtures can be used for side-dressing purposes.

The 13-26-13 and 10.5-21.5-21.5 listed above have given good results when used as side-dressings on limed and unlimed soils. Formulas for two additional fertilizers having different plant-food ratios are given below. One is a lower-nitrogen mixture (7.6-32-16) which has been found satisfactory for side-dressing purposes. The other, a much higher analysis (24-26-16), when applied in appreciable amounts, must be used on well-limed soils. It will cause trouble on an acid soil.

	7.6-32-16	24-26-16
"Ammo-Phos" 11-48	1000 lbs.	---
Muriate of potash 60%	534	---
Double superphosphate 48%	340	---
Gypsum	26	---
"Uramon" 42%	100	350 lbs.
Di-Ammonium phosphate 20% N-50% K_2O	---	980
Potassium nitrate 13% N- 44% K_2O	---	670
	2000	2000

Continued on next page

Magnesium Salts, Borax, and Manganese Sulfate: Where growers have determined a need for magnesium, addition of 100 pounds of magnesium sulfate (Epsom salts) per ton of fertilizer used in the side-dressing solution is sufficient. Dolomitic limestone may be used to supply magnesium at considerably less cost. Should boron or manganese deficiency develop, 10 to 20 pounds of borax or 20 pounds of manganese sulfate may be dissolved in the water which is applied per acre.

Liming Program

All of the formulas indicated are very low in calcium because it is impossible to have substantial amounts of both calcium and phosphoric acid in solution. Calcium is a very essential plant food. Large amounts are needed in any well-balanced fertilizer and soil-fertility program. If liquid fertilizers are to be used, it will be necessary to follow a good liming program. If this is done, both the calcium and magnesium requirements of the crop will be supplied through the use of dolomitic limestone.

Equipment

FOR APPLYING STARTER SOLUTIONS: No special equipment is needed to apply starter solutions used at transplanting. The regular water tank with which transplanters are equipped is satisfactory. For seed-sown crops, a 25- to 50-gallon tank, with a piece of hose and a spout to carry the solution into the drill with the seed, can be mounted on the planter in place of the dry-fertilizer hopper. This equipment can be made in the farm workshop.

FOR APPLYING SIDE-DRESSING LIQUIDS: A riding cultivator can be equipped with a tank to direct the liquid to each side of the plants, the open end of the hose being attached just back of the cultivator teeth. For tractor cultivators, a 100- to 150-gallon tank can be mounted at the rear of a tractor just above the draw-bar, and equipped to distribute the solution to the cultivator teeth. The liquid is distributed as close to the plants as the foliage permits. Late applications may be made down the middle of the row.

By removing the nozzles from spraying equipment, a stream the size of a lead pencil on each side of the row will apply 200 pounds of liquid fertilizer per acre. Special pumping machines which pump the water out of the tank are available. They apply the solution at a more uniform rate, and are easily regulated to apply 5, 10, 15, 20, or 25 gallons per minute.

Continued on next page

Quantities of Fertilizers to Use in Solutions

The following tabulation gives the amounts of mixed fertilizers in 50 gallons of water that may be used for different purposes when applied in liquid form.

Amounts of Mixed Fertilizers to Use in 50 Gallons of Water, Based On Total Application of 200 Gallons of Solution per Acre

STARTER SOLUTIONS

Nitrogen content of mixed fertilizer	For transplanting (Tomato, cabbage, pepper, egg-plants, sweet potatoes)		For seed sowing (Beans, corn, peas)	
	Amount in 50 gallons of water		Amount in 50 gallons of water	
	With dry fertilizer in row	With dry fertilizer broadcast*	In furrow with seed	As side-dressings
3 to 8%	None	4 to 10 lbs.	10 to 40 lbs.	25 to 50 lbs.
8 to 15%	"	2 to 4	5 to 10	10 to 25
15 to 25%	"	1 to 3	2 to 6	5 to 10

*Before or after plowing.

SIDE-DRESSINGS

Crop	Amount in 50 gallons of water	Number of Applications	Intervals after planting
Sweet corn, snap beans, spinach	10 to 25 lbs.	1	At emergence
Lima beans	10 to 25	3	Every 2 weeks
Tomatoes, eggplants	20 to 50	3-4	" 2 "
Sweet potatoes, peppers	10 to 25	3	" 2 "
Cabbage, cauliflower, broccoli	20 to 50	4	" 2 "

Agricultural News Letter (Du Pont)
Vol. 9, No. 2, March-April, 1941

STUDIES OF THE KEEPING QUALITIES OF CUT FLOWERS

EDITOR'S NOTE: Experimental work on factors that influence the keeping qualities of cut flowers, with special reference to the use of chemicals, has been underway at Ohio State University since 1934. Because the information developed by this research is of such widespread interest and importance, Professor Laurie, at our request, prepared the following article on this subject. It includes a brief review of the literature, a general discussion of the experimental procedure and results, and offers several chemical formulas which, he says, "may be useful in the actual keeping qualities of flowers".

By Alex Laurie,
Associate Horticulturist,
Ohio State University,
Columbus, Ohio.

The sporadic attempts by a number of workers to influence the keeping quality of cut flowers were based in the past largely on the reduction of bacterial decomposition of the stems submerged in water. Disinfecting chemicals and cutting of the basal portions to eliminate clogging of the conducting vessels were relied upon. Ratsek (1) showed that copper containers aided in keeping qualities, and ascribed it to the disinfecting action of copper released from the walls of the containers. Decker (2) indicated that flowers cut under water lasted longer, presumably due to the elimination of air from the conducting vessels. Hitchcock and Zimmerman (3) pointed out that low temperatures and high humidity were factors in prolonging the life of cut flowers. Thornton (4) showed that roses keep longer when stored at low temperatures with a high carbon dioxide content.

The studies at Ohio State University attempted to clarify the present conceptions, and to study not only the effect of various chemicals as disinfectants but as aids in water absorption and as agents in reducing the respiratory activities. Further studies were made to determine the place and rate of water absorption as well as the rate of respiration.

The Effect of Copper

Copper containers, copper wire, copper shavings, copper shot, and brass shot were used in the tests. The results obtained indicate that the prolongation of life of cut flowers as affected by copper varies with the type of plant used. One group included those which kept 1 to 2.7 days longer than controls. In this may be placed aster, godetia, clarkia, daffodil, stocks, snapdragons, annual chrysanthemum, calendula, nemesia, pansy, marigold, salpiglossis, and Boston yellow daisy. The second group showed no apparent difference in keeping

Continued on next page

quality between controls and copper containers. In this group may be placed schizanthus, rudbeckia, leptosyne, myosotis, feverfew, centaurea, penstemon, and others. In only one instance has copper proven detrimental -- the carnation, in which case the length of keeping was reduced by one day. The determination of copper content showed that 1.25 ppm were present, which was found to increase to 1.6 ppm when the containers were cleaned with sulphuric acid. When copper wire and copper shavings were used the copper content increased to 2.23 ppm. This added amount showed slight increases in keeping qualities. However, for practical purposes the use of copper wire in glass containers has a distinct advantage over the copper containers.

Effect of Cutting Stems Under Water

The effect of cutting stems under water as compared with those cut in the air likewise varies with the plant used. Those which were aided by being cut under water were snapdragon, carnation, sweet pea, Boston yellow daisy, aster, annual chrysanthemum, and marigold, while calendula and stocks showed no difference in effect. Anatomical studies of the stems showed a direct correlation in this respect between stems with large conducting vessels and those with small, the former being benefited less by the under-water cutting.

Absorption of Water by Cut Flower Stems

The common belief is that flowers keep longer in deep water than in shallow, presumably based on the assumption that absorption takes place all along the stem. Tests were made with numerous replications, placing flower stems in different depths of water ranging from ½-inch to 10 inches. These tests showed that all cut flowers tried kept as well in shallow water as in deep; in many instances shallow-water treatment increased the keeping qualities by 2 to 3 days. In this group may be included snapdragon, carnation, pansy, aster, Boston yellow daisy, annual chrysanthemum, daffodil, salpiglossis, godetia, coreopsis, delphinium, cosmos, and hunnemania. The explanation of these results lies in the fact that less surface is exposed to bacterial decomposition in the water, and that absorption takes place from the base of the stem as indicated in the next series of tests.

Place and Rate of Flower Absorption

Using a mixture of 1/3 vaseline and 2/3 paraffin, the stems of various cut flowers were sealed (a) completely, (b) along the sides, and (c) the base only. Control plants were not sealed.

Table I shows that in most cases the greater portion of the water is absorbed through the cut end of the stem. The stems which were sealed along the sides absorbed more water and lasted slightly longer than those which were not sealed at all. The most probable explanation is that in the sealed sides bacterial action was reduced with attendant greater absorption and longer keeping quality.

Continued on next page

Table I - Absorption of Water Through the Stems of Cut Flowers*

Crop	Stems Sealed Entirely		Stems Not Sealed		Base of Stem Sealed		Side of Stem Sealed		Temperature
	c.	Days	c.	Days	c.	Days	c.	Days	Degrees F.
Pansy	0	1	2.6	3	.16	1	2.5	4	65-70
Carnation	0	3	8	6	.8	3	7	6	65-70
Snapdragon	0	1	14	4	.8	1	15	4	65-70
Boston Yellow Daisy	0	1	4.3	6.7	1	5	3	6	65-70
Sweet Pea	0	1	1.3	3	.4	1	1.5	4	65-70
Cosmos	0	1	3.0	4	.13	1	4	4	75-80
Gaillardia	0	1	4.1	4	.16	1.0	4.3	4	75-80
Delphinium	0	1	21	5	.8	1	23.5	4	75-80
Larkspur	0	1	3.0	4	.9	1	7.5	5	75-80
Chrysanthemum Leucanthemum	0	1	8.6	6	1	1	10.6	6	75-80
Iris	0	1	37	7	12	3	40	7	75-80
Aster	0	1	18	8	3	2	17	8	75-80
Rose	0	1	8.0	4	1.0	1	7	4	75-80
Tritoma	0	1	33	5	1	1	42	5	75-80
Calendula	0	1	6.0	6	1	1	4	3	75-80
Hunnemania	0	1	3.0	3	3	3	3.2	3	85-100
Rudbeckia	0	1	20	4	1	1	23	4	85-100
Zinnia	0	1	50	4	1	3	54	4	85-100
Trachelium	0	1	10	4	1	1	18	4	85-100
Nasturtium	0	1	2.0	3	1	1	1.5	3.0	85-100

*Number of flowers tested was 30 to 100 for each variety.

Rate of Respiration

The rate of respiration has a bearing on the length of life of cut flowers. To determine the respiration rate, measurements of the carbon dioxide evolved were made by the carbonate precipitate method.

Table II - Rate of Respiration of Certain Cut Flowers

Crop	Number of c. of CO_2 Evolved per Hour
Aster	.0089
Boston yellow daisy	.01426
Carnation	.0285
Pansy	.3772
Snapdragon	.018

This table is but an indication of possible trends. Pansy shows the greatest amount of CO_2 given off per hour, while the aster shows the least amount. The keeping qualities of the pansy are proverbially low while those of the

Continued on next page

aster are correspondingly long. Hence the respiratory rate seems definitely related to the longevity of the cut flower stem and is inversely proportional to the keeping rate.

Effect of Chemicals on Respiration

Tests were made in an effort to slow up the metabolism of the plant by artificially lowering the respiration rate. Materials were sought which would decrease bacterial action, increase absorption and transpiration, provide the proper hydrogen-ion concentration and osmotic pressure. Of the many materials tried, only three showed any effect on cutting down the respiratory rate: hydrazine sulfate, phloroglucinol, and resorcinol. Sodium amytol was effective on sweet peas, presumably because of its coagulative action on proteins. Further preliminary studies indicate that combinations of metallic zinc powder in proper concentrations may control the factors responsible for keeping qualities of cut flowers; namely, reduction of bacterial activity, increase of transpiration, lowering the rate of respiration, and providing the most suitable pH and osmotic pressure.

Chemical Treatment of Cut Flowers

As a result of these studies, more recent work has enabled us to suggest several formulas which may be useful in the actual keeping qualities of flowers. No. 1 and No. 4 are particularly satisfactory for roses and carnations.

No. 1. Dissolve 1 ounce hydrazine sulfate in 1 quart of water, and use this as a stock solution. To another quart of water, add 2 teaspoonfuls of the hydrazine sulfate stock solution, 2 grams manganese sulfate, and 1 tablespoonful of sugar.

No. 2. Dissolve $\frac{1}{4}$ teaspoonful boric acid in 1 quart water. This is useful on carnations.

No. 3. A 10-15% sugar solution prolongs the life of China asters.

No. 4. To 1 quart water, add $\frac{1}{4}$ teaspoonful of potassium aluminum sulfate (commercial alum), $\frac{1}{4}$ teaspoonful sodium hypochlorite (Clorox), 1 pinch ferric oxide (iron rust), and 2 teaspoonfuls sugar. This solution is especially useful on cut roses.

Commercial products are also available.

Vitamin B_1 has NOT proven beneficial in prolonging the life of a wide range of flowers.

LITERATURE CITED

1. Ratsek, J. C. Tests metal containers in an attempt to increase life of cut flowers. Florists' Review, May 9, 1935.
2. Dorner, H. B. Handling cut flowers to prolong their keeping qualities. Florists' Exchange, April 28, 1934.
3. Hitchcock, A. E., and P. W. Zimmerman. Effects of chemicals, temperature, and humidity on the lasting qualities of cut flowers. Contrib. Boyce Thompson Inst. 2: No. 3. 1929.
4. Thornton, N. C. The use of carbon dioxide for prolonging the life of cut flowers with special reference to roses. Contrib. Boyce Thompson Inst. 2: No. 9. 1930.

Agricultural News Letter (Du Pont)
Vol. 9, No. 2, March-April, 1941

UREA SEASONING OF TIDEWATER RED CYPRESS

EDITOR'S NOTE: Previous issues of the Du Pont "Agricultural News Letter" have carried items regarding the use of urea in wood treatment. Vol. 8, No. 2, March-April, 1940, reviewed results of experimental work on the chemical seasoning of Douglas fir and hemlock on the West Coast. Vol. 8, No. 6, November-December, 1940, carried information on the use of urea to facilitate bending of wood. These articles created so much interest that we are including herewith a brief statement on tests utilizing urea for the chemical seasoning of tidewater red cypress.

The chemical seasoning of tidewater red cypress with crystal urea has been achieved practically and economically in mill-scale tests conducted for nearly three years by the Burton-Swartz Cypress Company of Florida.

Chemical treatment minimizes the tendency of lumber to check or split during the drying process, whether on the yard or in the kiln. Research conducted principally by the U.S. Forest Products Laboratory and the du Pont Company demonstrated the superiority of crystal urea over many other materials considered for chemical seasoning of lumber. Urea is exceptionally effective and has many desirable qualities.

Urea is a white, odorless, crystalline solid, produced synthetically by reacting ammonia with carbon dioxide at high pressure. It is inexpensive both to purchase and apply; it is not corrosive to metals used with wood; it does not dull tools; it does not cause "sweating" in treated lumber after the drying period; it makes the wood more flame retardant; and it is non-poisonous and harmless to the skin.

Ease of penetration of urea into lumber depends on moisture content of lumber. Therefore, it is essential to apply urea to the green wood immediately after sawing and before any checking, however minute, has had an opportunity to develop.

Tidewater red cypress, freshly cut, has a high moisture content, and it was found that urea could be applied as crystals and the lumber immediately strip piled for drying. With woods of lower green moisture content, it may be necessary to steam in the kiln for a short period or to bulk pile until the urea is absorbed.

The economy of this method of treatment for tidewater red cypress is evident. The only extra labor charge is that of applying the urea crystal to one surface of the lumber.

Continued on next page

Tidewater red cypress, like other softwoods in thickness up to six inches, requires approximately 40 pounds of urea per 1000 board feet of lumber to keep checking and splitting to a minimum.

In one test made by Burton-Swartz, two piles of high-grade four-inch tank stock, one treated and the other untreated, were placed in the yard under similar conditions. After eight months, the treated stock still was "Select and Better" grade, but the untreated stock had lowered in grade to that of "Shop and Better". On the basis of this test, it was estimated that without treatment this stock would have degraded by about $40 per thousand board feet.

A number of other softwoods as well as hardwoods have also been successfully treated with urea. However, conditions vary for species of woods, dimensions, and conditions of handling, and each potential treatment requires study and experimentation.

Agricultural News Letter (Du Pont)
Vol. 9, No. 2. March-April, 1941.

MEALYBUG ON APPLES

EDITOR'S NOTE: The following article reporting results of experiments on the control of Comstock's mealybug on apples was prepared by Dr. Schoene at our request. It reviews the outbreaks in Virginia during recent years, describes the nature of the injury to apples, and reports results of control measures, with a detailed summary of 1940 data.

By W. J. Schoene, Entomologist,
Virginia Experiment Station,
Blacksburg, Virginia.

A severe outbreak of the Comstock's mealybug, Pseudococcus comstocki, occurred on apple trees in a restricted area in Albemarle County, Virginia, in 1934. This infestation attracted attention not only because it was a new pest of apple but because of the enormous number of insects present and the severity of the injury. So far as can be determined, the insect on apple is the same as that studied by Hough on catalpa. (Va. Agr. Exp. Sta. Tech. Bul. 29)

Nature of Injury

The damage by the mealybug consists of injury to the fruit and to the foliage. When present in large numbers, there is a somewhat premature dropping of the foliage. The most damage, however, is due to the presence of a sooty fungus that feeds on the honeydew secreted by the insects. From midsummer to the latter part of the season, the insects confine their feeding almost entirely to the fruit and to that part of the twig immediately above the apple. The upper part of the apple thus becomes covered with this sticky substance. This tenacious sooty fungus is not removed entirely by any of the washing methods employed, and lowers the grade of the fruit. In addition to the injury mentioned, the fruit from mealybug injured trees does not keep well in storage.

Distribution and Spread

During the season of 1934 the insect was found in several orchards in one locality in Albemarle County, and it appeared to be spreading rapidly. The injury was severe in 1934, but generally much less during the next two seasons. In midsummer of 1936, it was found in one orchard in Roanoke County, and later in the same year in an orchard in Clarke County. During the next two years, the insect spread to several orchards in Clarke and Frederick Counties. It was also found in an orchard in Botetourt County in close proximity to the orchard in Roanoke County. The history of the damage in each of these orchards was somewhat similar; namely, the injury was very severe during the first year that it was observed, but generally much less injurious the second year.

Continued on next page

By the end of 1939, it was apparent that the insect was not spreading to nearby orchards, and scouting disclosed that the insect was causing damage only in the older orchards which had been well cared for, thoroughly sprayed, and in which nitrogenous fertilizer had been applied. Dr. W. S. Hough found by counting injured fruit that there was considerable difference in injury to young and old trees. On trees 38 years old, 29 per cent of the fruit was damaged, whereas on replants, 15 to 18 years old, standing adjacent to these older trees, only 6 per cent of the fruit was damaged.

Life History

The life history of Pseudococcus comstocki was studied during 1923 and 1924 on catalpa at Winchester, and was found to have three broods and to hibernate in the egg stage. The insect on apple appears to have substantially the same life cycle as previously observed on catalpa. In the season of 1940, however, many of the third brood individuals did not mature, due to the wet weather and a cool spring. This would indicate that for 1940, there were two complete broods and a partial third brood.

Enemies

There is one Hymenopterous parasite, Clausenia purpurea Ishii, associated with the mealybug in each of the infested orchards. In some seasons, this parasite has materially reduced the population of the mealybugs. During August, 1940, following a period of very heavy rain, a fungus appeared that greatly reduced the population in some orchards. This fungus appeared in the three different sections of the State where the insect occurs, but was more effective in the area north of Roanoke.

Control

The control measures attempted thus far consist first of winter clean-up and secondly of summer spraying.

In each of the orchard sections, there has been an attempt by growers to reduce the population of the insect by scraping the bark during the dormant season, and thoroughly spraying the trees with oil or tar oil. This winter clean-up, in some instances, has been so thorough that the population of the insect the following season was greatly reduced.

In the first years in which the insect occurred, attempts were made to reduce the numbers by the use of nicotine sprays, and such evidence as is available indicates that there was considerable reduction in some instances. During the season of 1940, tests were made of various contact insecticides including nicotine and one of the thiocyanates ("Loro" contact insecticide). These tests indicate that if the sprays are applied for the first and second broods, and while the insects are in the first or second stage, their numbers can be appreciably reduced. The tests also indicate that these contact insecticides may have considerable value for certain other insect pests of the orchard; but, owing to the presence of the fungus mentioned, there was not always a striking difference between the sprayed and unsprayed trees.

Continued on next page

The latest publication on the control of this pest is one entitled "A Preliminary Report on the Control of Comstock's Mealybug on Apple", by Dr. J. A. Cox, Virginia Agricultural Experiment Station, Department of Entomology. This appeared in the January issue of "Virginia Fruit" 29 (1):84-88:1941. The following table showing the performance of nicotine sulfate and thiocyanate ("Loro") sprays is condensed from this report, but the summary is quoted unchanged.

Table 1. Data on the control of Comstock's mealybug on apple in 1940.

Materials and amounts for 100 gallons spray	Date of application	Mealybugs killed by spray		Number of live mealybugs or fruit spurs after sprays were applied	Injured fruit at picking time
		1st brood	2nd brood		
"Loro", 1 pint. Grasselli spreader sticker, ½ pint	5-13 5-22	98%	----	70	60.6%
"Loro", 1 pint. Grasselli spreader sticker, ½ pint	5-13 5-22 7-22 7-29	98	97.7%	36	11.2
"Loro", 2/3 pt. Grasselli spreader sticker, ½ pint	7-22 7-29	--	90.0	160	41.9
"Loro", ¼ pint. Grasselli spreader sticker, ½ pint	7-22 7-29 8--5		90.1	140	44.8
Nicotine sulfate, 1 quart Grasselli spreader sticker, ½ pint	7-22 7-29 8--5		96.8	50	3.0
Check - No spray				1600	92.3

These experiments indicate that two applications of "Loro" (1:800) for each of the first and second broods, applied when the mealybugs were in the first and second instars, gave satisfactory control. Three applications of 40 per cent nicotine sulfate (1:400) were quite effective in controlling the young crawlers. Two applications of summer oil for the second brood crawlers, used at the rate of 1 gallon to 100 gallons of spray, did not give satisfactory control, but when combined with rotenone-bearing insecticides gave promising results.

The results for 1940 indicate that in a heavily infested orchard, although an insecticide kills 90 to 95 per cent of the mealybugs of the first and second broods, there may be a sufficient number of insects left on the tree to cause considerable damage to the fruit at harvest time."

Agricultural News Letter (Du Pont)
Vol. 9, No. 2. March-April, 1941

PHENOTHIAZINE FOR THE ANTHELMINTIC TREATMENT OF HORSES

EDITOR'S NOTE: In an article on "The Use of Phenothiazine in Veterinary Parasitology", in "Canadian Journal of Comparative Medicine", December, 1940, W. E. Swales, Division of Animal Pathology, Science Service, Dominion Department of Agriculture, and the Institute of Parasitology, Macdonald College, P.Q., states that the rapidly increasing number of papers on phenothiazine and the popular publicity afforded this new anthelmintic make desirable a summary of existing knowledge regarding practical application. Asserting that the promiscuous use of phenothiazine by the general public would lead to disappointment, he summarizes available data on treatment of sheep, horses, pigs, cattle, poultry, and other animals. References covering nearly all the work on phenothiazine in veterinary parasitology are appended. The following article, one of a series in the Du Pont "Agricultural News Letter", is an extract from Swales' paper. It is restricted to a discussion of phenothiazine for horses, and is used by permission of the author.

Researches in the United States and in Great Britain have shown that phenothiazine is of extraordinary value as an anthelmintic for the strongyloid nematodes of horses. These parasites, particularly Strongylus spp. are of definite pathological importance; in many areas in Canada strongylidosis per se or as a complicating factor in other diseases, is an important problem. Until now the only efficient anthelmintic which has been readily available has been oil of chenopodium; this anthelmintic has been employed in combination with laxative oils. N-butylidene chloride is also highly efficient, but has not been generally available for use. Thus phenothiazine has gained extraordinary publicity as a possible safe substitute for the other anthelmintics, which in the opinion of some practitioners, have undesirable characteristics. The publicity has even led to horse owners hailing the chemical as an end to all parasite troubles in horses, in that it can be merely added to the feed without danger. This dangerous premise, unless checked, will have serious results and will lead to an unfair estimation of the value of this anthelmintic for horses.

The preliminary work in Washington followed by reports of independent work in Great Britain and later by tests in Kentucky and New York have provided a good basis for preliminary recommendations and for further work on the effect of phenothiazine and its derivatives on the host animal.

Doses of from 60 to 100 grams of phenothiazine, given in the food or by other means to horses of various weights are highly efficient in removing the strongyloid nematodes. The preliminary critical tests of 80 to 90 gram doses

Continued on next page

to animals weighing from 1100 to 1200 lbs. indicate almost 100 per cent efficiency. In other published work the criterion of success is measured by quantitative faecal egg counts. In Great Britain even 20 gms. reduced such counts in cavalry horses by more than 50 per cent.

The effect on Parascaris equorum is indefinite, and it is doubtful if phenothiazine will have an action comparable to carbon disulphide in this regard. No effect upon bot larvae has been demonstrated. Thus this new treatment will not replace the use of carbon disulphide but may be used to augment the routine treatments, so that infections with strongyloid worms can be dealt with as readily as roundworms and bot larvae.

Workers with phenothiazine are familiar with a haemolytic effect which is evident in certain small animals that have received repeated small doses or single very large doses. In the tests with horses the reports indicate that phenothiazine exerts a toxic effect; this is seen as clinical symptoms ranging from slight malaise to abdominal pain and definite anaemia. In practically all treated horses a drop in the haemoglobin and erythrocytes occurred; this has also been noted by others in actual practice. The bronzed or yellowed mucous membranes noted in treated animals in Great Britain and in the United States are no doubt related to the haemolysis and consequent excess formation of bile pigments.

From the available data it is obvious that phenothiazine is a good anthelmintic for use against strongyloid worms in horses, but it must be used cautiously and by qualified veterinarians. If used promiscuously, particularly in an area in which infectious anaemia is prevalent, serious losses are almost certain to occur. Any symptom of anaemia is a contraindication.

Complete elimination of Strongylidae in horses is not possible. The free-living stages of these parasites are able to survive on pasture over the winter and even for years under other adverse conditions. Almost every horse is exposed to large numbers of infective larvae, but only under certain circumstances does resistance break down and allow large numbers of worms to become established and produce clinical strongylidosis. Thus, a treatment need only reduce the infection to a low level; the evident efficiencies of doses of about 50 gms. indicate that such amounts should be adequate under most circumstances. The minimum dose should be 30 grams, and the usual dose for an average farm animal should be about 60 grams. At the present time doses exceeding 80 grams should be given with caution. From analogy, repeated doses in horses would be dangerous.

Agricultural News Letter (Du Pont)
Vol. 9, No. 2. March-April 1941.

"HUNGER SIGNS IN CROPS"

EDITOR'S NOTE: While it does not ordinarily come within the scope of the "Agricultural News Letter" to review new books, it was felt that an exception could be made in connection with "Hunger Signs in Crops". This new non-profit book summarizes in practical form much of the existing knowledge of the symptoms that develop in growing crops when they lack needed plant-food elements. It is characterized by H. R. Smalley and Charles J. Brand of The National Fertilizer Association as "the most outstanding contribution to our knowledge of plant nutrition and use of fertilizers that has been made in a generation". It represents five years' work by a group of scientists, all of whom worked without compensation. The Committee on Fertilizers of the American Society of Agronomy, through its Subcommittee on Symptoms of Malnutrition in Plants, assumed the responsibility of assigning the chapters to competent authors and preparing the material for publication. The Plant Food Research Committee of The National Fertilizer Association assumed the responsibility of finding a way to publish the book, which is now available at the low price of $2.50. It consists of 300 pages of text and illustrations, including 80 full-page color plates, as well as many halftones. It is handsomely bound in durable green cloth.

Science has proved that many so-called crop diseases are merely "hunger signs" -- symptoms of plant-food deficiencies or "hidden hunger". Farmers originally gave these mysterious diseases such names as "fired" corn, "sand drown" in tobacco, "die back" in citrus, "drought spot" in apples, "heart rot" in beets, "rust" in cotton, and many others.

"Hunger Signs in Crops", a new book, published jointly by the American Society of Agronomy and The National Fertilizer Association, brings under one cover much of the available information on this subject, as compiled and written by outstanding specialists in agronomy, horticulture, plant nutrition, and crop diseases.

The nine chapter headings cover the background and other introductory material, tobacco, cotton, corn and small grains, potatoes, vegetables, legumes, deciduous fruits, and citrus fruits.

Nutritional Needs and Hunger Symptoms of Various Crops Included

The background material tells what hunger signs are, how they are studied, and what they mean. It was prepared by Dr. George D. Scarseth, Soil Chemist, Purdue

Continued on next page

University, and by Dr. Robert M. Salter, Director of the North Carolina Agricultural Experiment Station and Chairman of the Committee on Fertilizers, American Society of Agronomy.

The chapter on tobacco was prepared by Dr. James E. McMurtrey, Jr., Senior Physiologist in the Tobacco Division, Bureau of Plant Industry, U. S. Dept. of Agriculture. Dr. McMurtrey covers the subject thoroughly. The tobacco plant, incidentally, proved to be especially well adapted to nutrition studies.

Dr. H. P. Cooper, Dean, School of Agriculture, Clemson College, and Director of the S. C. Experiment Station, summarizes the results of many experiments dealing with nutritional needs and hunger symptoms in the cotton plant.

Dr. George N. Hoffer, formerly of Purdue University, now Mid-West Manager of the American Potash Institute, used corn as an example for nutritional deficiencies in grain crops, and tells what is known about symptoms in small grains.

Dr. Henry A. Jones, In Charge of Potato Investigations, and Bailey E. Brown, Senior Biochemist, both of the Bureau of Plant Industry, show what happens to potato plants that lack various nutritive elements.

Dr. J. J. Skinner, Senior Biochemist, Bureau of Plant Industry, puts major emphasis on the tomato plant, but covers a wide range of other important vegetable crops.

Dr. E. E. DeTurk, Professor of Soil Technology, University of Illinois, describes the hunger signs in legumes, the crops that can get their nitrogen from the air but draw heavily on the soil for other plant foods.

Dr. O. W. Davidson, Assistant in Research Pomology, New Jersey Experiment Station, tells what has been discovered about "hidden hunger" in deciduous fruits.

Several authorities combine on a practical discussion of nutritional deficiencies in citrus fruits. These authors are Dr. A. F. Camp, Horticulturist in Charge, Citrus Experiment Station, Lake Alfred, Fla.; George M. Bahrt, Associate Soil Technologist, Bureau of Plant Industry; Dr. H. D. Chapman, Associate Chemist, and Dr. E. R. Parker, Assistant Horticulturist, both of the Citrus Experiment Station, Riverside, Calif.

The entire book was edited by Gove Hambidge, Principal Research Writer, Office of Information, U. S. Dept. of Agriculture.

For further information, write H. R. Smalley, Chief Agronomist, The National Fertilizer Association, 616 Investment Building, Washington, D. C.

Agricultural News Letter (Du Pont)
Vol. 9 No. 2. March-April, 1941.

AMMONIUM SULFAMATE AND SULFAMIC ACID AS HERBICIDES

EDITOR'S NOTE: The data presented in this article represent a further report of progress in the evaluation of ammonium sulfamate as a weed killing chemical by Du Pont investigators. Additional data of a very favorable nature have been described in private communications from qualified research people in many sections of the country. There is room for considerable detailed research in this field in order to determine the efficiency and optimum methods of applying ammonium sulfamate to any specific type of weed under the particular local conditions which may be involved. To facilitate investigations of this kind, the Grasselli Chemicals Department of the Du Pont Company is offering samples of the chemical to qualified investigators who are in a position to conduct suitable comparative tests. A plant for the manufacture of sulfamic acid and ammonium sulfamate is now under construction and commercial quantities are expected to be available within the next few months.

Harry F. Dietz,
M. A. Vogel and
Harold Cupery

In the March-April 1940 issue of the Du Pont Agricultural News Letter, Martin E. and Harold Cupery reported the promising results obtained with sulfamic acid and certain of its salts, particularly ammonium sulfamate, as weed killers. The examination of their test plots in the spring of 1940 confirmed the preceding season's observations on the particular sensitivity of poison ivy to sulfamic acid and its ammonium salt. Practically no survival of this weed was found, even where a heavy and luxuriant growth of it had been treated the preceding season. The experiments here reported are a continuation of those previously initiated in Delaware and are an extension of experiments to two widely separated areas in northern Ohio where weather and soil conditions are quite different from those along the eastern seaboard.

The threefold purpose of the 1940 tests was: (1) To evaluate the herbicidal efficiency, particularly of ammonium sulfamate, not only against poison ivy but against as wide a range of weeds as practical; (2) to make a direct comparison of the effectiveness of ammonium sulfamate with sulfamic acid and of such weed killers as sodium chlorate, ammonium thiocyanate and ammonium sulfate; (3) to determine the effect of the time of application in the growing season of the plants on the performance of ammonium sulfamate.

To this end seven different experiments comprising a minimum of three and a maximum of ten tests were conducted in Delaware. Test plots were, with one exception, 100 square feet in area and were located along weedy fence rows,

Continued on next page

where poison ivy occurred along with a considerable variety of other weeds. The application of the herbicides in five experiments was made with a four gallon compressed air sprayer. In the other two experiments where extremely corrosive test materials were included applications were made with a sprinkling can. In every experiment ammonium sulfamate, at a concentration of one pound dissolved in a gallon of water applied at the rate of one gallon to 100 square feet of land area, was included as a reference or control. In four of the experiments sodium chlorate at the same rate was also used as a direct reference material and in two others a proprietary chlorate-chloride mixture was used.

Applications in these experiments were made June 15; July 6, 8, 13 and 20; August 21 and September 9.

Poison ivy occurred in all experiments except the one with Canada thistle, and in two other experiments wild dewberry (Rubus procumbens) and Indian currant (Symphoricarpos racemosus) were the principal woody weeds used for comparison along with poison ivy.

The herbaceous weeds in the test plots were yarrow, goldenrod, wild carrot, dogbane (Apacynum androemifolium), fall asters of the novae angliae type, whitetop fleabane, nettle (Urtica sp.), ragweed, toad flax (Linaria vulgaris) and smartweed. Wild onion was an abundant weed in one experiment, but not in all. Timothy was an associate in most test plots, as was red clover.

The maximum time interval between the application of the herbicides and rainfall was eight days, the minimum four hours. The weather during these experiments ranged from unusually cool in early July to unusually hot from the middle to the end of that month.

The growth condition of poison ivy, the reference woody weed in all tests ranged from very tender in mid-June to tough and fully matured in September.

In the two experiments in which ammonium sulfamate and sodium chlorate were directly compared with ammonium sulfate and ammonium thiocyanate, at the rate of one pound per one gallon applied to 100 square feet of ground area, only the ammonium sulfamate and sodium chlorate gave adequate control of all weeds present. Only on wild onion was the sodium chlorate more effective than ammonium sulfamate.

The maximum injury to poison ivy with ammonium sulfate was an 80% defoliation of luxurious growth five feet high, after which the plants grew as vigorously as before. The maximum injury with ammonium thiocyanate to this weed was the very rapid killing of all foliage and succulent growth. However, after three weeks new growth appeared and by frost these plants had almost recovered. Similar results were obtained with ammonium sulfate and thiocyanate on dewberry and blackberry, as well as on ivy, in a second test so that both materials were dropped from further consideration. Even on herbaceous weeds, all of which were over one foot high at the time these materials were applied, ammonium sulfate was only partially effective and was far inferior to ammonium thiocyanate.

Continued on next page

In experiments in which ammonium sulfamate and a proprietary sodium chlorate-chloride mixture were directly compared at half strength (½ lb. per gallon per 100 square feet area), the former was superior to the latter. The half-strength sulfamate dosage was just as effective as full-strength material on poison ivy and herbaceous weeds, but slightly inferior to it on dewberry.

In none of the Delaware experiments did any poison ivy sprayed with full, three-fourths and half-strength ammonium sulfamate show any recovery in the way of new growth either from root suckers or buds from the wood. In fact, the wood of five-foot high plants was dead and brittle down to the ground line when examined six weeks after the plants were sprayed. The same results were obtained with sodium chlorate, but not with the chlorate-chloride mixture. With this latter mixture some recovery in the way of new growth or suckers appeared before frost.

In direct comparisons between treatments of ammonium sulfamate and sulfamic acid there was no noticeable difference in ultimate efficiency. Sulfamic acid had the psychological advantage of very rapid wilting of the treated plants. In this respect it was equal to ammonium thiocyanate which was the most rapid acting herbicide, though transient, tested. However, sulfamic acid in solution was very reactive with metal equipment and on this account has not been so seriously investigated as its ammonium salt.

One of the most important features of ammonium sulfamate observed in Delaware experiments was that the rapidity of its action was influenced by humidity and rainfall and to some degree possibly by temperature. Although it is a dry, crystalline material at relative humidities under 70 per cent, it picks up moisture from the air at higher humidities. Even though it is very soluble in water, ammonium sulfamate does not seem to be leached from the plants by heavy rain occurring within a few hours after application. Foliage sprayed with ammonium sulfamate has a distinctly glazed appearance when the spray dries. Where rainfall did not occur within several days after ammonium sulfamate was applied its maximum wilting action and complete collapse of the foliage did not occur until after rain. This was confirmed in two independent demonstration tests on poison ivy.

In Delaware tests on Canada thistle, ammonium sulfamate was equal to the chlorate-chloride mixture in effectiveness in a single application made to tall plants just before they were coming into bloom. However, neither treatment gave a complete kill of all plants, probably because the low growing shoots (biennial phase) were not thoroughly wetted, since they were protected by the higher flowering shoots.

Three experiments with poison ivy as the test plant were conducted in Ohio. In the first experiment in early July (conducted on low dense mats of ivy under apple trees) the effectiveness of ammonium sulfamate, sulfamic acid and sodium chlorate, all used at the rate of one pound per gallon per 100 square feet, applied with a compressed air sprayer, was compared. The ammonium sulfamate and sulfamic acid killed the plants and no new growth from the roots appeared. In the sodium chlorate plot, in contrast to the Delaware tests, new growth appeared

Continued on next page

by late October. The second experiment, August 3, was of the demonstration type on the same kind of ivy growth under trees in a large orchard in the northwestern part of the state. Application at the rate of 5/7 pound per gallon was made with an orchard power sprayer. The killing of the aerial parts of the plants was thorough, even to the point of being spectacular. No new growth appeared before frost. The third test on fence row poison ivy was made on September 6 with similar results on the aerial growth. Roots from sprayed plants were placed in cutting beds in December, but have shown no sign of growth two months later.

A word of caution on the use of orchard power sprayers in applying herbicides is desirable. The spray tank, pumps and hoses must be thoroughly washed out after use. Otherwise, serious damage to fruit trees will occur from the first one or two tankfuls of pest-control spray that are applied subsequently with the equipment.

The most extensive Canada thistle control experiments with ammonium sulfamate were conducted in north-central Ohio, July 4 and 10. Application was made with a compressed air, barrel and wheelbarrow power sprayer on both heavy and spotted stands of plants. Some were just ready to bloom (two to three feet high) and others, young plants (biennial form) following an earlier mowing, were from four to eight inches high. Reference plots sprayed with sodium chlorate and with sulfamic acid were included. In these tests it was determined that to wet thoroughly heavy stands of plants with any material required the application of approximately two gallons of spray per 100 square feet of land area.

The aerial parts of the plants were killed within a week with all three materials. It was observed also that plants sprayed with sulfamic acid wilted faster than those sprayed with ammonium sulfamate which confirms Delaware observations. In September the plots were carefully checked. It was found that on plants having any part of the stem green, the roots were dead and deteriorating for about 6 inches below ground. Beyond this there were live buds, and in some cases subterranean shoots several inches in length were found. In contrast, plants in which no green was present on the stems had the roots dead to a depth of 14 to 18 inches. No buds were found on the apparently live parts of the roots beyond this and no growth was induced from root cuttings planted in sand in the greenhouse. Root cuttings from untreated plants or plants showing any green on the stems readily produced buds and plants.

It was also indicated that spraying Canada thistle at or near blooming stage is more effective than treating the low-growing biennial form. This may be due to the fact that because of the greater leaf surface of such plants more of the herbicide is absorbed and translocated farther. This will be discussed in another article on the mechanism of the action of ammonium sulfamate as a weed killer.

Bitter dock (Rumex obtusifolius) and dandelion which occurred in the test plots among the thistles were also killed.

Continued on next page

SUMMARY

The following conclusions are warranted on the basis of this year's tests:

Ammonium sulfamate properly and thoroughly applied is an effective weed killer for poison ivy, Canada thistle and a miscellany of succulent, herbaceous weeds.

On poison ivy, dosages between ½ and 1 pound per gallon of water applied at a rate of one to one and one-half gallons per 100 square feet of land area have given excellent kill of the plants.

Some form of sprayer is most satisfactory in order to secure the necessary wetting of the plants.

From the standpoint of conserving material the compressed air knapsack sprayer has advantages, except where large areas are to be treated.

Pressure is not an important factor as long as good coverage is obtained.

Ammonium sulfamate is not particularly selective as a weed killer. Crop plants such as blue grass, timothy, white and red clover are killed, if wetted by the spray, as readily as are the weeds associated with these plants.

At present, ammonium sulfamate is not competitive on a cost basis with the cheaper chlorate and soluble arsenical sprays, but it has distinct advantages over both. It does not present the fire hazard of the chlorates which precludes the use of these admittedly effective weed killers in sod or straw mulched orchards, where poison ivy is often a serious, and occasionally costly, menace to susceptible workers. It does not have the serious poison hazard which precludes the use of the soluble arsenicals where warm blooded browsing animals may have access to sprayed plants.